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Is the current drought affecting the Western US unique from earlier droughts of the 20thCentury and therefore attributable to anthropogenic climate change?

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Abstract: Our proposed research seeks to assess whether or not the drought currently affecting the western US is distinguishable from previous droughts during the 20th century. Climate model simulations forced with anthropogenic greenhouse gases predict decreased P-E over the southwestern US during the 21st century in response to a combination of mean humidity change, change in the mean circulation and changes in eddy circulation behavior. It is not yet clear which of these factor(s) accounts for the present drought. Previous droughts during the 20th and pre-20th century have been attributed to anomalously cool, La Niña SSTs in the tropical Pacific and multi-decadal temperature variability in the North Pacific associated with the Pacific Decadal Oscillation. The current drought has persisted in the absence of La Niña conditions, which raises the question of whether it is due in part to anthropogenic forcing.

In previous studies we suggested that northward-southward shifts in storm tracks alongthe west coast of the US occurred repeatedly during the past millennia and that these shifts are documented in the isotopic mass balance of the annual precipitation that is a mixture of tropical/subtropical and extratropical water vapor sources (Berkelhammer and Stott, 2009; Berkelhammer and Stott, 2008). Our initial findings were based on d18O measurements of cellulose extracted from the annual rings of long-lived trees in California, which derives its isotopic composition from rainwater and local humidity and temperature. We suggested that as mean storm trajectories shifted southward, precipitation incorporated proportionally more subtropical moisture, which is isotopically more enriched. This isotopic enrichment is transferred to cellulose of annual tree rings. Our findings documented a close correspondence between drought and decreased tropical/subtropical moisture convergence over the southwestern US during the 20th century. In other words, previous droughts over the southwest were accompanied by a northward shifts in mean storm tracks. We do not observe a similar isotopic shift in association with the current drought.

The study proposed here would create a database of annual cellulose and rain waterd18O from a suite of locations along the west coast spanning the 20th century and combine this with a newly developed isotope-enabled global climate model-derived reanalysis product. With these results we will quantitatively calibrate isotopic variability of precipitation against explicit climate variability over the 20th century in a way that was hitherto not feasible. In doing so, we will reconstruct changes in moisture source variability and storm track behavior that influenced the regional water balance with a particular focus on water source variations at the onset, peak and end of multi-year drought and times of short-lived ENSO-related drought and pluvials. At the completion of the three year project we will have developed a new well-calibrated 20thcentury isotope reanalysis product, extending

the late 20th century products of Yoshimura et al.,(2008) through the early 20th century. The results of this study will provide an independent test of how the current drought compares to previous droughts and provide an isotopic reanalysis product that can be used by others in the interpretation of paleo-hydrologic proxies. This collaborative endeavor brings together the experience of Lowell Stott and Max Berkelhammer of USC in isotopic measurements and data analysis with Kei Yoshimura of Scripps Institution of Oceanography (SIO) who has developed the isotope-enabled GSM.